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fig.1, pl.I

加拿大北极地区黄昏鸟化石

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摘要 加拿大北极地区 Bylot 岛晚白垩世陆相沉积中发现一黄昏鸟化石。这是首次在极地地区发现这类不会飞行的已绝灭的潜水鸟类，该地点也是白垩纪最晚期的黄昏鸟产地。新材料的形态构造与 *Hesperornis regalis* 比较接近，但它个体大，颈椎椎体后部特别向两侧扩展，椎体侧凹亦特别大而深等，具特化的性状，因而建一新属新种：*Canadaga arctica* gen. et. sp. nov.。

关键词 加拿大 Bylot 岛，晚白垩世，黄昏鸟科，形态学

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1991 年初，笔者访问加拿大国家博物馆时，古生物学家 Dale A. Russell 教授将他和董枝明教授等从北极 Baffin 岛东北 Bylot 岛上采集的黄昏鸟类化石提供给本人研究。近几年，因中国北方广大地区相继发现大批十分有价值的中生代早期鸟类化石，因此将这批材料迟至今日才研究出来。

黄昏鸟 (*Hesperornis* Marsh, 1872) 绝大多数分布于北美，特别是 Kansas 的 Niobrara 组。加拿大西部的 Alberta 省曾发现该属的一左跗跖骨，化石出自 Forement 组 (middle Campanian)。在 Bylot 岛发现的这批黄昏鸟材料，为已知距北极极地中心最近的化石产地，也是时代最晚的黄昏鸟化石。

黄昏鸟目 Hesperornithiformes Furbringer, 1888

黄昏鸟科 Hesperornithidae Marsh, 1872

加拿大鸟 (新属) *Canadaga* gen. nov.

北极加拿大鸟 (新种) *Canadaga arctica* sp. nov.

(图 1; 图版 I)

正型标本 3 个相连的颈椎，加拿大国家博物馆标本号 NMC 41050。

归入标本 尾椎 1 枚，NMC 41064; 股骨两块，NMC 41053, 41054。

层位及产地 加拿大，Bylot 岛，晚白垩世中马斯特里克特阶 (middle Maastrichtian)，中部砂岩层。

特征 颈椎椎体后部向两侧扩展，其宽超过后关节突之宽；椎体侧凹 (concavites lateralis) 特别大而深，腹下突 (Proc. ventralis) 大，占据椎体腹侧前中部。脊神经弓背突 (神经棘) (Arcus vertebrae, Proc. dors) 短而粗，弹性韧带区 (Area lig. elastici) 位脊神经弓背突

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的前方。

描述　3 枚颈椎关连在一起，前后两枚保存不全。从椎体的形态观察及与 *Hesperornis*(Marsh, 1872)的完整脊柱比较，这 3 枚颈椎当为第 15～17 枚颈椎，椎体双凹型。背视，仅有前两个颈椎具有比较完整的神经弓，前面颈椎的前关节突(prezygapophysis)缺失，脊神经弓背突，前两枚仅保存基部，但可推测背突相当短，最后 1 枚未保存，第 2 枚神经弓背突较第 1 枚稍长，其弹性韧带区凹下，在两前关节面之后弹性韧带区两侧各有一凹陷，相当明显。后关节突(postzygapophysis)之间的夹角为锐角，不超过 90°，后关节突背面有一小平台，这一性质与 *Hesperornis* 相同。前关节突收缩，但关节面大，呈椭圆形，向内侧倾斜。

侧视：最重要的特征是椎体侧凹很大而且深，侧凹占据了椎体的整个侧面，前面一个颈椎者最大，第二个稍小，第三个保存不全。左右两侧的肋骨关节凹(fovea artic)大而突出，位于横突之下、侧突(parapophysis)的末端。新记述的标本与 *Hesperornis* 不同之处在于其肋骨凹与椎体之间有一收缩凹。横突(transverse process)保存不全，仅剩基部，可观察到横突内部是一空腔，骨壁比较厚，这一腔很深，可能与神经管(neural canal)相通，这也是与已知黄昏鸟相区别的特征之一。

腹视：椎体前缘为一凹的弧形，而椎体后缘则呈一扇形，两侧向外扩展，其宽超过背侧后关节突的宽度。椎体腹侧从前缘至椎体后部具一大的腹下突(Proc. ventralis)，也叫下突

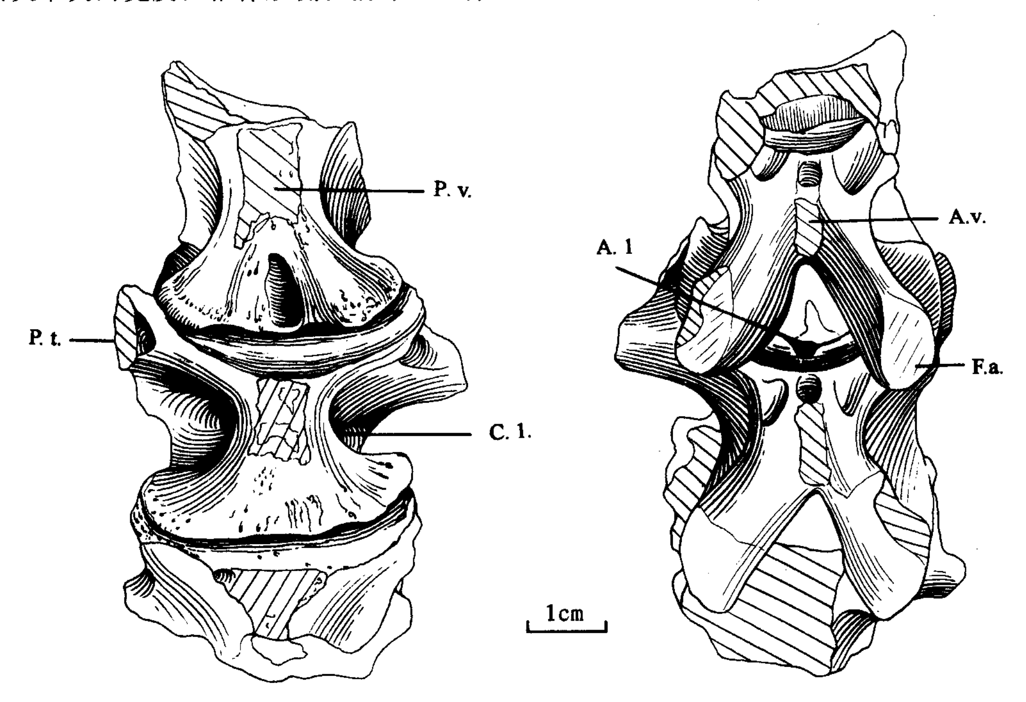


图 1　北极加拿大鸟颈椎(NMC 41050)　左，腹视；　右，背视

Fig. 1　*Canadaga arctica* cervicals(NMC 41050) left, ventral view; right, dorsal view

A. l-Area lig. elastici 弹性韧带区；A. v.-Arcus vertebrae: Proc. dors. 脊神经弓背突(神经棘)；C. l-concavitas lateralis 椎体侧凹；F. a-facies articularis 后关节面；P. t.-Proc. transversus 椎体横突；P. v.-Proc. ventralis 椎体腹下突(下突起)

起(hypapophysis)。虽然突起没有全部保存下来,但从其剩余的部分已完全看出它占据着椎体腹侧的主要部分。迄今为止,还没有资料证明其腹下突占据有这样大的位置,通常仅局限在椎体腹侧前边缘,这说明新黄昏鸟颈部肌肉异常发达,攻击能力很强。椎体后腹部为深的坑凹,这也是很特殊的形态。

归入标本中,尾椎1枚,后部保存不全。这枚尾椎椎体窄长,也为双凹型椎体,从破损的地方观察,椎体内是空腔,骨壁比较薄。前视有一细小的脊神经孔。神经弓顶面为一长沟向下凹陷。侧视,神经弓与椎体之间具一浅凹,椎体侧面压缩。腹视,腹中凹宽而长。尾椎保存长29mm、椎体横宽6.5mm。

股骨两块,上下两端都未保存。从形态看,大小虽然有别,但都不是成年个体者。骨体稍弯曲,骨壁较厚,表面有少量血管孔。保存长分别为40mm和45mm。

讨论 本文记述的这一大型化石鸟类产地,是迄今为止世界鸟类化石产地最接近北极极地的一处。其脊椎的形态特征,如双凹型脊椎、神经棘短、椎体短、两端扩展等,显示出黄昏鸟科的特征。该科目前至少有7属14种鸟类,与北极加拿大鸟可以对比和较接近的是美国Kansas晚白垩世Niobrara组的*Hesperornis regalis*(Marsh, 1872),它们的共同特征是:椎体短,侧凹发育、大,以及都有比较低的神经棘等。加拿大鸟与其他黄昏鸟类不同的性状为:1)加拿大鸟椎体侧凹特别大而深,几乎占据了整个椎体侧面;2)椎体末端扩展呈扇形,而椎体中部收缩很细;3)腹下突特别大;4)具有明显的弹性韧带区,这是较已知黄昏鸟进步的构造,与现生鸟类相似;5)后关节突之间的夹角呈锐角,明显区别于黄昏鸟,后者该夹角超过90°;6)神经弓之前有一特殊的下陷区。

加拿大西部Alberta省发现的*Hesperornis*幼体的跗蹠骨(Fox,1974),其沉积环境虽不是海相,但为带有盐味接近滨岸的河口或海湾沉积。同产的其他脊椎动物还有恐龙和鳄类等。北极加拿大鸟产于陆相三角洲地带,同产的有恐龙(鸭嘴龙)和鱼类等,与Alberta产黄昏鸟的沉积环境虽然不太相同,但动物群的性质似乎很相似。

黄昏鸟目的化石材料,除*Enaliornis*一属发现于英国早白垩世之外,其他全为北美地区特有化石鸟类,至白垩纪结束,全部绝灭。它们具有明显的区域性,在亚洲、南美等白垩纪,特别是晚白垩世发现的不具飞行能力的鸟类与黄昏鸟类的形态差异非常大。而黄昏鸟的形态构造不但与分布北半球的海雀(*Auk*)等相近,也与生活于南半球的企鹅(*Penguin*)有某些相似的构造,如头低、嘴长、颈椎短、前肢退化、腰带相对窄长等,可能具有一共同祖先,在早白垩世这些鸟类的祖先出现之后就迅速分化、辐射,分散于地球不同的地理区系,繁衍生息。

感谢侯晋封绘图,张杰摄制图版。

NEW HESPERORNITHID (AVES) FROM THE CANADIAN ARCTIC

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Key words Bylot Island, Arctic Canada, Late Cretaceous, Hesperornithidae, morphology

Summary

In early 1991, when I was at the Canadian National Museum, Dr. D. A. Russell kindly provided me some hesperornithid fossils for study. The specimens were collected from Bylot Island, Canada.

Hesperornis is largely restricted to North America, especially in the Niobrara Formation of the United States (Feduccia, 1996) The youngest individual of the genus, represented by a left tarsometatarsus, was recovered from Western Alberta in Canada (Fox, 1974). The hesperornithid fossils from the Bylot Island represent the latest record of the Hesperornithidae, and the northernmost occurrance so far. The large size and morphologic specializaion are the main cause for its extinction.

Order Hesperornithiformes Furbringer, 1888

Family Hesperornithidae Marsh, 1872

***Canadaga* gen.nov.**

***Canadaga arctica* sp.nov.**

(fig, 1; pl. I)

Holotype Three cervicals, Canadian National Museum Specimen Number NMC 41050.

Referred specimens One caudal vertebra (NMC 41064); two femurs (NMC 41053, NMC 41054).

Locality and horizon Bylot Island, Canada; Late Cretaceous, mid-Maastrichtian.

Diagnosis Posterior part of cervical vertebrae expanded laterally, centrum wider than width of zygapophysis; concavitas lateralis large and deep, large process ventralis occupys its anteromiddle part of ventral side of centrum; dorsal process of the vertebrate arch short and robust. Area of elastic ligument anterior to arcus vertebrae dorsal process.

Description The three cervicals are articulated, with the anterior and the posterior ones incompletely preserved. On the basis of their morphology and comparison with

the complete vertebral column of *Hesperornis* (Marsh 1880), the three cervicals are probably 15～17. The neural spine is lower, but can be interpreted as quite short. The spine of the third cervical is not preserved. The angle between the postzygapophysis is no more than 90°, with a dorsal small horizontal surface on the postzygapophysis. This character resembles that of *Hesperornis.* The prezygapophysis is constricted, but the large articular surface is slightly elliptical and slant inwards.

In lateral view, the most significant character is a large and deep concavitas lateralis occupying the entire lateral surface of centrum. The fovea artic. costalis on both sides are large and prominent, located below the transverse process and the end of parapophysis. The new specimen is different from *Hesperornis* in having a fovea between the costal fossa and centrum. Only the base of the transverse process is preserved, but with a clear cavity inside the process. The cavity is deep, and probably connected with the neural canal. This character distinguishes the new genus from other known hesperornithids.

The hypapophysis extends from the anterior rim to the middle part of the centrum. So far, no other known hesperornithids shows such a large process ventralis. Normally, the process is located at the anterior rim of the centrum. The posteroventral part of the centrum has a deep depression, which is distinct morphologically.

Measurements of the 16th vertebra (in mm)

Length of centrum—28

Transverse diameter of anterior articulation of centrum—30

Vertical diameter of anterior articulation of centrum—17

Transverse diameter of posterior articulation of centrum—36

Vertical diameter of posterior articulation of centrum—16

Transverse diameter of vertebra, across prezygapophysis—33

Transverse diameter of vertebra, across diapophysis—41

Transverse diameter of vertebra, across postzygapophysis—33

Diameter of prezygapophysis—15

Transverse diameter of postzygapophysis—15

The caudal vertebra is amphicoelous, long and narrow. The centrum is hollow, having a relatively thin wall. In anterior view, the centrum has a tiny foramen for a nerve. The dorsal surface of the neural arch has a long groove. Laterally, the centrum is compressed, and has a shallow depression between the arch and the centrum. Ventrally, the centrum is slightly expanded, with a wide and long depression. The caudal is 29mm as preserved, and is 6.5mm in width. This is probably the last segament of the synsacral caudal vertebrae, and is also a juvenile individual.

The two femurs are incomplete, with both ends unpreserved. On the basis of morphology, they are not from adult individuals, although the two show difference in

size. The femur is slightly curved, having relatively thick wall, and some surface foramen for blood vessels. The two bones are preserved as 40mm for one and 45mm for the other.

Comparison and discussion This large fossil bird is from the polar region and the northernmost locality known so far. On the basis of vertebra morphology, the new fossil bird should be referred to the Hesperornithidae (Martin, 1976). Hesperornithidae includes at least 14 species in seven genera, among which the closest to the new bird from Arctic Canada is *Hesperonis regalis* from the Late Cretaceous Niobrara Formation, Kansas, Logan County, the United States. The new bird is similar to *Hesperornis regalis* in the following characters: centrum short, concavitas lateralis well developed, transverse process long, and neural spine low. On the other hand, *Canadaga* shows differences from known *Hesperornis*, e. g. 1) concavitas lateralis is large and deep, occupying almost the entire lateral surface of the centrum; 2) the end of the centrum has a fan-shaped expansion, while the middle part of the centrum is strongly constricted; 3) process ventralis large; 4) possession of well developed area elastic ligament, which is a derived condition in relation to *Hesperornis*, but similar to modern birds; 5) the angle between the postzygapophysis is less than 90°; 6) neural arch has a distinct depression anterior to the spine.

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Explanations of Plate I

Canadaga arctica gen. et sp. nov. NMC 41050, ×1.6

cervical vertebra, upper: dorsal view; lower: ventral view

